



## Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

### General Description

The MAX481, MAX483, MAX485, MAX487–MAX491, and MAX1487 are low-power transceivers for RS-485 and RS-422 communication. Each part contains one driver and one receiver. The MAX483, MAX487, MAX488, and MAX489 feature reduced slew-rate drivers that minimize EMI and reduce reflections caused by improperly terminated cables, thus allowing error-free data transmission up to 250kbps. The driver slew rates of the MAX481, MAX485, MAX490, MAX491, and MAX1487 are not limited, allowing them to transmit up to 2.5Mbps.

These transceivers draw between 120 $\mu$ A and 500 $\mu$ A of supply current when unloaded or fully loaded with disabled drivers. Additionally, the MAX481, MAX483, and MAX487 have a low-current shutdown mode in which they consume only 0.1 $\mu$ A. All parts operate from a single 5V supply.

Drivers are short-circuit current limited and are protected against excessive power dissipation by thermal shutdown circuitry that places the driver outputs into a high-impedance state. The receiver input has a fail-safe feature that guarantees a logic-high output if the input is open circuit.

The MAX487 and MAX1487 feature quarter-unit-load receiver input impedance, allowing up to 128 MAX487/MAX1487 transceivers on the bus. Full-duplex communications are obtained using the MAX488–MAX491, while the MAX481, MAX483, MAX485, MAX487, and MAX1487 are designed for half-duplex applications.

### Applications

Low-Power RS-485 Transceivers  
 Low-Power RS-422 Transceivers  
 Level Translators  
 Transceivers for EMI-Sensitive Applications  
 Industrial-Control Local Area Networks

### Next Generation Device Features

#### ♦ For Fault-Tolerant Applications

MAX3430:  $\pm$ 80V Fault-Protected, Fail-Safe, 1/4 Unit Load, +3.3V, RS-485 Transceiver  
 MAX3440E–MAX3444E:  $\pm$ 15kV ESD-Protected,  $\pm$ 60V Fault-Protected, 10Mbps, Fail-Safe, RS-485/J1708 Transceivers

#### ♦ For Space-Constrained Applications

MAX3460–MAX3464: +5V, Fail-Safe, 20Mbps, Profibus RS-485/RS-422 Transceivers  
 MAX3362: +3.3V, High-Speed, RS-485/RS-422 Transceiver in a SOT23 Package  
 MAX3280E–MAX3284E:  $\pm$ 15kV ESD-Protected, 52Mbps, +3V to +5.5V, SOT23, RS-485/RS-422, True Fail-Safe Receivers  
 MAX3293/MAX3294/MAX3295: 20Mbps, +3.3V, SOT23, RS-855/RS-422 Transmitters

#### ♦ For Multiple Transceiver Applications

MAX3030E–MAX3033E:  $\pm$ 15kV ESD-Protected, +3.3V, Quad RS-422 Transmitters

#### ♦ For Fail-Safe Applications

MAX3080–MAX3089: Fail-Safe, High-Speed (10Mbps), Slew-Rate-Limited RS-485/RS-422 Transceivers

#### ♦ For Low-Voltage Applications

MAX3483E/MAX3485E/MAX3486E/MAX3488E/MAX3490E/MAX3491E: +3.3V Powered,  $\pm$ 15kV ESD-Protected, 12Mbps, Slew-Rate-Limited, True RS-485/RS-422 Transceivers

*Ordering Information appears at end of data sheet.*

### Selection Table

PART NUMBER	HALF/FULL DUPLEX	DATA RATE (Mbps)	SLEW-RATE LIMITED	LOW-POWER SHUTDOWN	RECEIVER/DRIVER ENABLE	QUIESCENT CURRENT ( $\mu$ A)	NUMBER OF TRANSMITTERS ON BUS	PIN COUNT
<b>MAX481</b>	Half	2.5	No	Yes	Yes	300	32	8
<b>MAX483</b>	Half	0.25	Yes	Yes	Yes	120	32	8
<b>MAX485</b>	Half	2.5	No	No	Yes	300	32	8
<b>MAX487</b>	Half	0.25	Yes	Yes	Yes	120	128	8
<b>MAX488</b>	Full	0.25	Yes	No	No	120	32	8
<b>MAX489</b>	Full	0.25	Yes	No	Yes	120	32	14
<b>MAX490</b>	Full	2.5	No	No	No	300	32	8
<b>MAX491</b>	Full	2.5	No	No	Yes	300	32	14
<b>MAX1487</b>	Half	2.5	No	No	Yes	230	128	8

MAX481/MAX483/MAX485/MAX487-MAX491/MAX1487

# Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V <sub>CC</sub> )	12V
Control Input Voltage (RE, DE)	-0.5V to (V <sub>CC</sub> + 0.5V)
Driver Input Voltage (DI)	-0.5V to (V <sub>CC</sub> + 0.5V)
Driver Output Voltage (A, B)	-8V to +12.5V
Receiver Input Voltage (A, B)	-8V to +12.5V
Receiver Output Voltage (RO)	-0.5V to (V <sub>CC</sub> + 0.5V)
Continuous Power Dissipation (T <sub>A</sub> = +70°C)	
8-Pin Plastic DIP (derate 9.09mW/°C above +70°C)	727mW
14-Pin Plastic DIP (derate 10.00mW/°C above +70°C)	800mW
8-Pin SO (derate 5.88mW/°C above +70°C)	471mW

14-Pin SO (derate 8.33mW/°C above +70°C)	667mW
8-Pin μMAX (derate 4.1mW/°C above +70°C)	830mW
8-Pin CERDIP (derate 8.00mW/°C above +70°C)	640mW
14-Pin CERDIP (derate 9.09mW/°C above +70°C)	727mW
Operating Temperature Ranges	
MAX4_C_/_MAX1487C_A	0°C to +70°C
MAX4_E_/_MAX1487E_A	-40°C to +85°C
MAX4_MJ/_MAX1487MJA	-55°C to +125°C
Storage Temperature Range	-65°C to +160°C
Lead Temperature (soldering, 10sec)	+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## DC ELECTRICAL CHARACTERISTICS

(V<sub>CC</sub> = 5V ±5%, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Differential Driver Output (no load)	V <sub>OD1</sub>			5		V
Differential Driver Output (with load)	V <sub>OD2</sub>	R = 50Ω (RS-422)	2			V
		R = 27Ω (RS-485), Figure 4	1.5	5		
Change in Magnitude of Driver Differential Output Voltage for Complementary Output States	ΔV <sub>OD</sub>	R = 27Ω or 50Ω, Figure 4		0.2		V
Driver Common-Mode Output Voltage	V <sub>OC</sub>	R = 27Ω or 50Ω, Figure 4		3		V
Change in Magnitude of Driver Common-Mode Output Voltage for Complementary Output States	ΔV <sub>OD</sub>	R = 27Ω or 50Ω, Figure 4		0.2		V
Input High Voltage	V <sub>IH</sub>	DE, DI, $\bar{RE}$	2.0			V
Input Low Voltage	V <sub>IL</sub>	DE, DI, $\bar{RE}$		0.8		V
Input Current	I <sub>IN1</sub>	DE, DI, $\bar{RE}$		±2		μA
Input Current (A, B)	I <sub>IN2</sub>	DE = 0V; V <sub>CC</sub> = 0V or 5.25V, all devices except MAX487/MAX1487	V <sub>IN</sub> = 12V		1.0	mA
			V <sub>IN</sub> = -7V		-0.8	
		MAX487/MAX1487, DE = 0V, V <sub>CC</sub> = 0V or 5.25V	V <sub>IN</sub> = 12V		0.25	mA
			V <sub>IN</sub> = -7V		-0.2	
Receiver Differential Threshold Voltage	V <sub>TH</sub>	-7V ≤ V <sub>CM</sub> ≤ 12V	-0.2	0.2		V
Receiver Input Hysteresis	ΔV <sub>TH</sub>	V <sub>CM</sub> = 0V		70		mV
Receiver Output High Voltage	V <sub>OH</sub>	I <sub>O</sub> = -4mA, V <sub>ID</sub> = 200mV	3.5			V
Receiver Output Low Voltage	V <sub>OL</sub>	I <sub>O</sub> = 4mA, V <sub>ID</sub> = -200mV		0.4		V
Three-State (high impedance) Output Current at Receiver	I <sub>OZR</sub>	0.4V ≤ V <sub>O</sub> ≤ 2.4V		±1		μA
Receiver Input Resistance	R <sub>IN</sub>	-7V ≤ V <sub>CM</sub> ≤ 12V, all devices except MAX487/MAX1487		12		kΩ
		-7V ≤ V <sub>CM</sub> ≤ 12V, MAX487/MAX1487		48		kΩ

# Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

## DC ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = 5V \pm 5\%$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
No-Load Supply Current (Note 3)	I <sub>CC</sub>	MAX488/MAX489, DE, DI, RE = 0V or V <sub>CC</sub>	120	250		μA
		MAX490/MAX491, DE, DI, RE = 0V or V <sub>CC</sub>	300	500		
		MAX481/MAX485, RE = 0V or V <sub>CC</sub>	DE = V <sub>CC</sub>	500	900	
			DE = 0V	300	500	
		MAX1487, RE = 0V or V <sub>CC</sub>	DE = V <sub>CC</sub>	300	500	
			DE = 0V	230	400	
		MAX483/MAX487, RE = 0V or V <sub>CC</sub>	DE = 5V	MAX483	350	650
				MAX487	250	400
			DE = 0V		120	250
Supply Current in Shutdown	I <sub>SHDN</sub>	MAX481/483/487, DE = 0V, RE = V <sub>CC</sub>	0.1	10		μA
Driver Short-Circuit Current, V <sub>O</sub> = High	I <sub>OSD1</sub>	-7V ≤ V <sub>O</sub> ≤ 12V (Note 4)	35	250		mA
Driver Short-Circuit Current, V <sub>O</sub> = Low	I <sub>OSD2</sub>	-7V ≤ V <sub>O</sub> ≤ 12V (Note 4)	35	250		mA
Receiver Short-Circuit Current	I <sub>OSR</sub>	0V ≤ V <sub>O</sub> ≤ V <sub>CC</sub>	7	95		mA

## SWITCHING CHARACTERISTICS—MAX481/MAX485, MAX490/MAX491, MAX1487

( $V_{CC} = 5V \pm 5\%$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
Driver Input to Output	t <sub>PLH</sub>	Figures 6 and 8, RD <sub>IFF</sub> = 54Ω, C <sub>L1</sub> = C <sub>L2</sub> = 100pF	10	30	60	ns	
	t <sub>PHL</sub>		10	30	60		
Driver Output Skew to Output	t <sub>SKEW</sub>	Figures 6 and 8, RD <sub>IFF</sub> = 54Ω, C <sub>L1</sub> = C <sub>L2</sub> = 100pF	5	10		ns	
Driver Rise or Fall Time	t <sub>R</sub> , t <sub>F</sub>	Figures 6 and 8, RD <sub>IFF</sub> = 54Ω, C <sub>L1</sub> = C <sub>L2</sub> = 100pF	MAX481, MAX485, MAX1487	3	15	40	ns
			MAX490C/E, MAX491C/E	5	15	25	
			MAX490M, MAX491M	3	15	40	
Driver Enable to Output High	t <sub>ZH</sub>	Figures 7 and 9, C <sub>L</sub> = 100pF, S2 closed	40	70		ns	
Driver Enable to Output Low	t <sub>ZL</sub>	Figures 7 and 9, C <sub>L</sub> = 100pF, S1 closed	40	70		ns	
Driver Disable Time from Low	t <sub>LZ</sub>	Figures 7 and 9, C <sub>L</sub> = 15pF, S1 closed	40	70		ns	
Driver Disable Time from High	t <sub>HZ</sub>	Figures 7 and 9, C <sub>L</sub> = 15pF, S2 closed	40	70		ns	
Receiver Input to Output	t <sub>PLH</sub> , t <sub>PHL</sub>	Figures 6 and 10, RD <sub>IFF</sub> = 54Ω, C <sub>L1</sub> = C <sub>L2</sub> = 100pF	MAX481, MAX485, MAX1487	20	90	200	ns
			MAX490C/E, MAX491C/E	20	90	150	
			MAX490M, MAX491M	20	90	200	
t <sub>PLH</sub> - t <sub>PHL</sub>   Differential Receiver Skew	t <sub>SKD</sub>	Figures 6 and 10, RD <sub>IFF</sub> = 54Ω, C <sub>L1</sub> = C <sub>L2</sub> = 100pF		13		ns	
Receiver Enable to Output Low	t <sub>ZL</sub>	Figures 5 and 11, C <sub>RL</sub> = 15pF, S1 closed	20	50		ns	
Receiver Enable to Output High	t <sub>ZH</sub>	Figures 5 and 11, C <sub>RL</sub> = 15pF, S2 closed	20	50		ns	
Receiver Disable Time from Low	t <sub>LZ</sub>	Figures 5 and 11, C <sub>RL</sub> = 15pF, S1 closed	20	50		ns	
Receiver Disable Time from High	t <sub>HZ</sub>	Figures 5 and 11, C <sub>RL</sub> = 15pF, S2 closed	20	50		ns	
Maximum Data Rate	f <sub>MAX</sub>		2.5			Mbps	
Time to Shutdown	t <sub>SHDN</sub>	MAX481 (Note 5)	50	200	600	ns	

MAX481/MAX483/MAX485/MAX487-MAX491/MAX1487

## Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

### SWITCHING CHARACTERISTICS—MAX481/MAX485, MAX490/MAX491, MAX1487 (continued)

( $V_{CC} = 5V \pm 5\%$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Enable from Shutdown to Output High (MAX481)	$t_{ZH(SHDN)}$	Figures 7 and 9, $C_L = 100\text{pF}$ , S2 closed		40	100	ns
Driver Enable from Shutdown to Output Low (MAX481)	$t_{ZL(SHDN)}$	Figures 7 and 9, $C_L = 100\text{pF}$ , S1 closed		40	100	ns
Receiver Enable from Shutdown to Output High (MAX481)	$t_{ZH(SHDN)}$	Figures 5 and 11, $C_L = 15\text{pF}$ , S2 closed, A - B = 2V		300	1000	ns
Receiver Enable from Shutdown to Output Low (MAX481)	$t_{ZL(SHDN)}$	Figures 5 and 11, $C_L = 15\text{pF}$ , S1 closed, B - A = 2V		300	1000	ns

### SWITCHING CHARACTERISTICS—MAX483, MAX487/MAX488/MAX489

( $V_{CC} = 5V \pm 5\%$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.) (Notes 1, 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Input to Output	$t_{PLH}$	Figures 6 and 8, $R_{DIFF} = 54\Omega$ , $C_{L1} = C_{L2} = 100\text{pF}$	250	800	2000	ns
	$t_{PHL}$		250	800	2000	
Driver Output Skew to Output	$t_{SKEW}$	Figures 6 and 8, $R_{DIFF} = 54\Omega$ , $C_{L1} = C_{L2} = 100\text{pF}$		100	800	ns
Driver Rise or Fall Time	$t_R, t_F$	Figures 6 and 8, $R_{DIFF} = 54\Omega$ , $C_{L1} = C_{L2} = 100\text{pF}$	250		2000	ns
Driver Enable to Output High	$t_{ZH}$	Figures 7 and 9, $C_L = 100\text{pF}$ , S2 closed	250		2000	ns
Driver Enable to Output Low	$t_{ZL}$	Figures 7 and 9, $C_L = 100\text{pF}$ , S1 closed	250		2000	ns
Driver Disable Time from Low	$t_{LZ}$	Figures 7 and 9, $C_L = 15\text{pF}$ , S1 closed	300		3000	ns
Driver Disable Time from High	$t_{HZ}$	Figures 7 and 9, $C_L = 15\text{pF}$ , S2 closed	300		3000	ns
Receiver Input to Output	$t_{PLH}$	Figures 6 and 10, $R_{DIFF} = 54\Omega$ , $C_{L1} = C_{L2} = 100\text{pF}$	250	2000	ns	
	$t_{PHL}$		250	2000		
$ t_{PLH} - t_{PHL} $ Differential Receiver Skew	$t_{SKD}$	Figures 6 and 10, $R_{DIFF} = 54\Omega$ , $C_{L1} = C_{L2} = 100\text{pF}$		100		ns
Receiver Enable to Output Low	$t_{ZL}$	Figures 5 and 11, $C_{RL} = 15\text{pF}$ , S1 closed	20	50		ns
Receiver Enable to Output High	$t_{ZH}$	Figures 5 and 11, $C_{RL} = 15\text{pF}$ , S2 closed	20	50		ns
Receiver Disable Time from Low	$t_{LZ}$	Figures 5 and 11, $C_{RL} = 15\text{pF}$ , S1 closed	20	50		ns
Receiver Disable Time from High	$t_{HZ}$	Figures 5 and 11, $C_{RL} = 15\text{pF}$ , S2 closed	20	50		ns
Maximum Data Rate	$f_{MAX}$	$t_{PLH}, t_{PHL} < 50\%$ of data period	250			kbps
Time to Shutdown	$t_{SHDN}$	MAX483/MAX487 (Note 5)	50	200	600	ns
Driver Enable from Shutdown to Output High	$t_{ZH(SHDN)}$	MAX483/MAX487, Figures 7 and 9, $C_L = 100\text{pF}$ , S2 closed			2000	ns
Driver Enable from Shutdown to Output Low	$t_{ZL(SHDN)}$	MAX483/MAX487, Figures 7 and 9, $C_L = 100\text{pF}$ , S1 closed			2000	ns
Receiver Enable from Shutdown to Output High	$t_{ZH(SHDN)}$	MAX483/MAX487, Figures 5 and 11, $C_L = 15\text{pF}$ , S2 closed			2500	ns
Receiver Enable from Shutdown to Output Low	$t_{ZL(SHDN)}$	MAX483/MAX487, Figures 5 and 11, $C_L = 15\text{pF}$ , S1 closed			2500	ns

# Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

## NOTES FOR ELECTRICAL/SWITCHING CHARACTERISTICS

**Note 1:** All currents into device pins are positive; all currents out of device pins are negative. All voltages are referenced to device ground unless otherwise specified.

**Note 2:** All typical specifications are given for  $V_{CC} = 5V$  and  $T_A = +25^\circ C$ .

**Note 3:** Supply current specification is valid for loaded transmitters when  $DE = 0V$ .

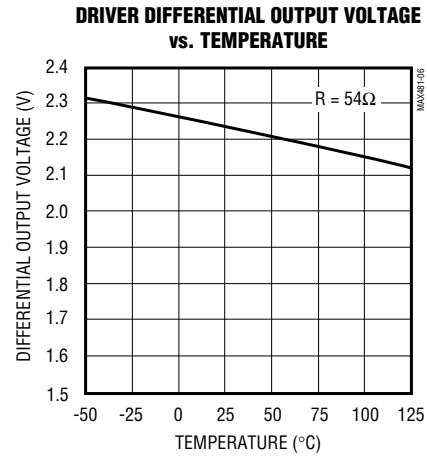
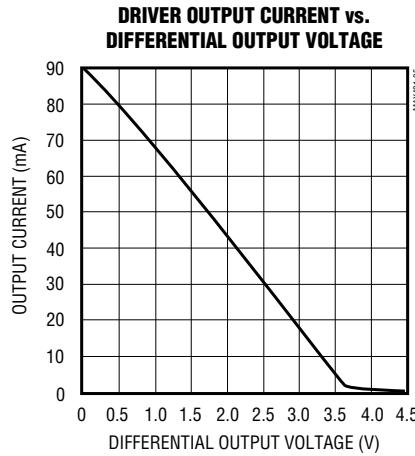
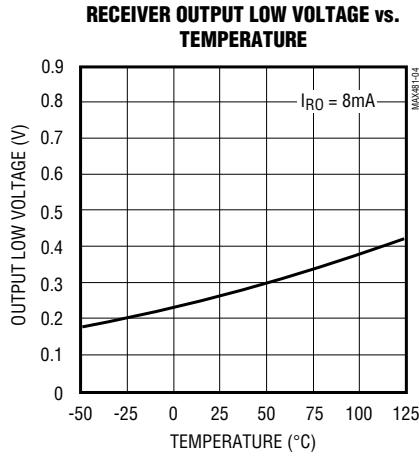
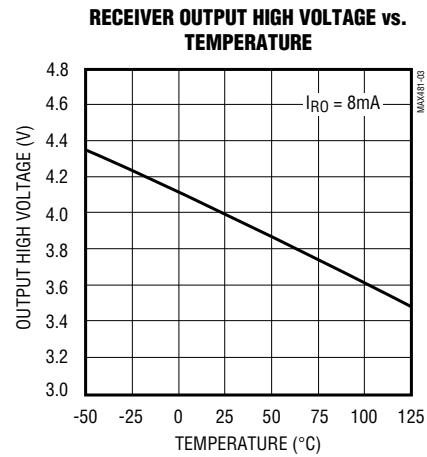
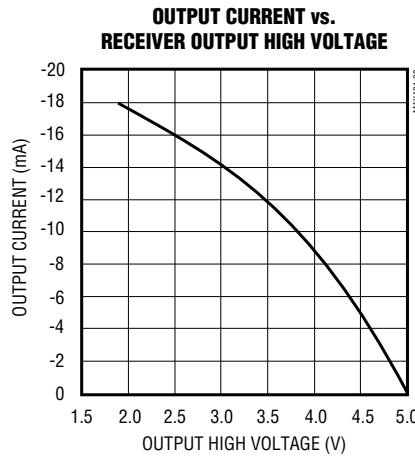
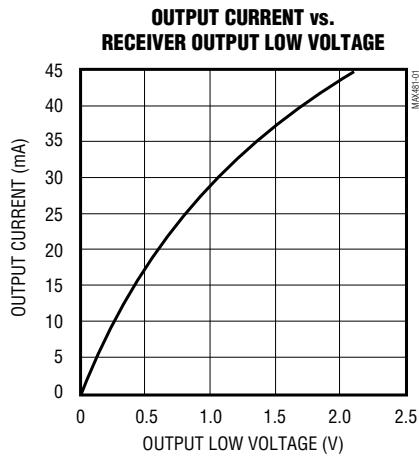
**Note 4:** Applies to peak current. See *Typical Operating Characteristics*.

**Note 5:** The MAX481/MAX483/MAX487 are put into shutdown by bringing  $\overline{RE}$  high and  $DE$  low. If the inputs are in this state for less than 50ns, the parts are guaranteed not to enter shutdown. If the inputs are in this state for at least 600ns, the parts are guaranteed to have entered shutdown. See *Low-Power Shutdown Mode* section.

**MAX481/MAX483/MAX485/MAX487-MAX491/MAX1487**

## Typical Operating Characteristics

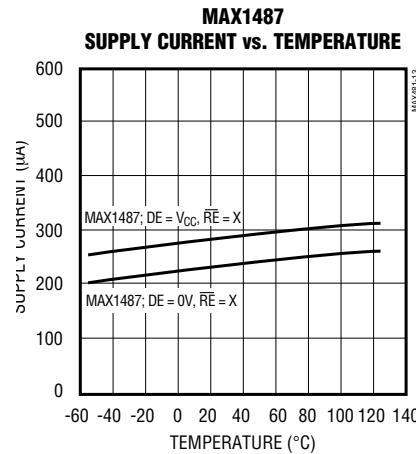
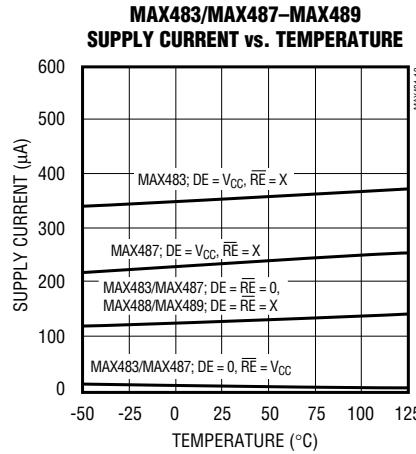
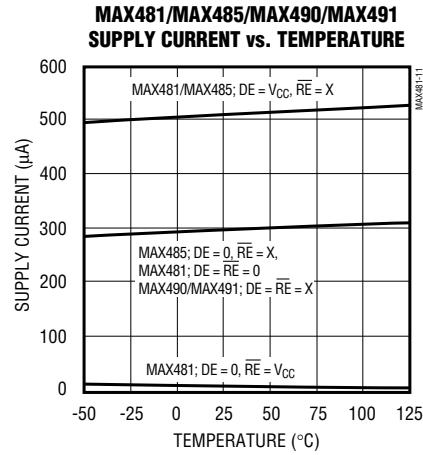
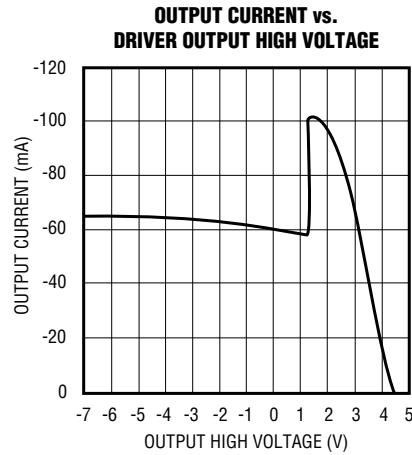
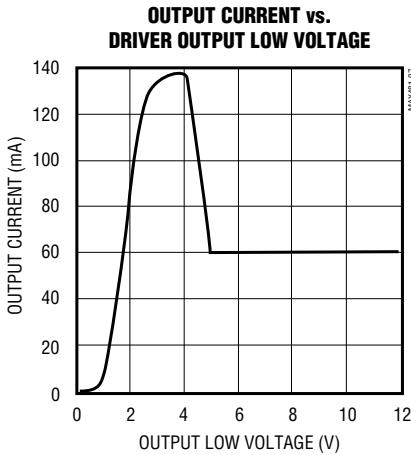
( $V_{CC} = 5V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



# Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

## Typical Operating Characteristics (continued)

( $V_{CC} = 5V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



# Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

## Pin Description

PIN					NAME	FUNCTION
MAX481/MAX483/ MAX485/MAX487/ MAX1487		MAX488/ MAX490		MAX489/ MAX491		
DIP/SO	$\mu$ MAX	DIP/SO	$\mu$ MAX	DIP/SO		
1	3	2	4	2	RO	Receiver Output: If A > B by 200mV, RO will be high; If A < B by 200mV, RO will be low.
2	4	—	—	3	$\overline{RE}$	Receiver Output Enable. RO is enabled when $\overline{RE}$ is low; RO is high impedance when $\overline{RE}$ is high.
3	5	—	—	4	DE	Driver Output Enable. The driver outputs, Y and Z, are enabled by bringing DE high. They are high impedance when DE is low. If the driver outputs are enabled, the parts function as line drivers. While they are high impedance, they function as line receivers if $\overline{RE}$ is low.
4	6	3	5	5	DI	Driver Input. A low on DI forces output Y low and output Z high. Similarly, a high on DI forces output Y high and output Z low.
5	7	4	6	6, 7	GND	Ground
—	—	5	7	9	Y	Noninverting Driver Output
—	—	6	8	10	Z	Inverting Driver Output
6	8	—	—	—	A	Noninverting Receiver Input and Noninverting Driver Output
—	—	8	2	12	A	Noninverting Receiver Input
7	1	—	—	—	B	Inverting Receiver Input and Inverting Driver Output
—	—	7	1	11	B	Inverting Receiver Input
8	2	1	3	14	VCC	Positive Supply: $4.75V \leq VCC \leq 5.25V$
—	—	—	—	1, 8, 13	N.C.	No Connect—not internally connected

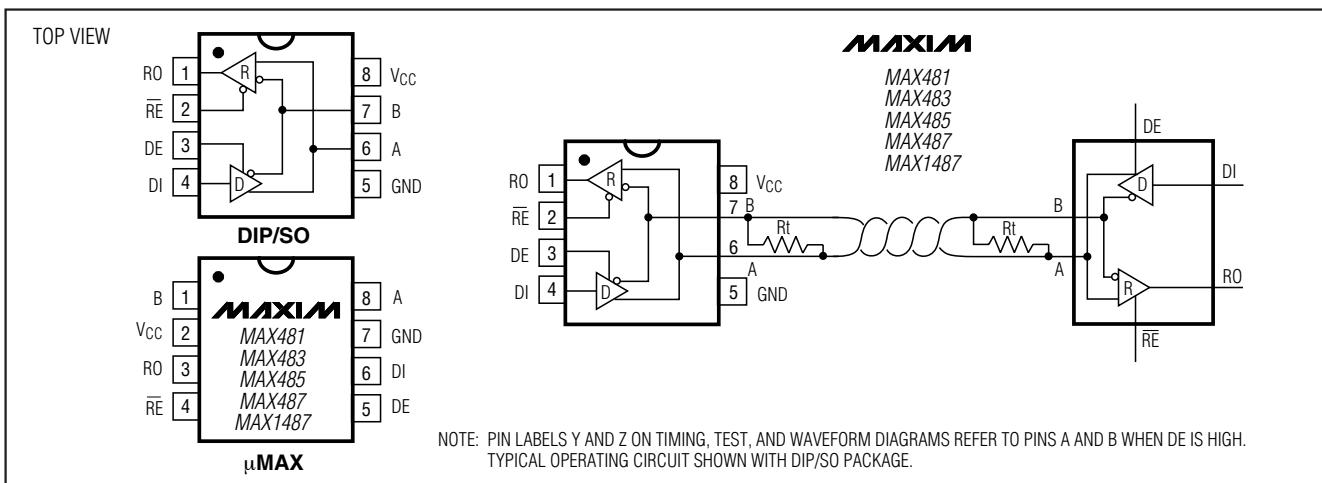


Figure 1. MAX481/MAX483/MAX485/MAX487/MAX1487 Pin Configuration and Typical Operating Circuit

MAX481/MAX483/MAX485/MAX487-MAX491/MAX1487

## Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

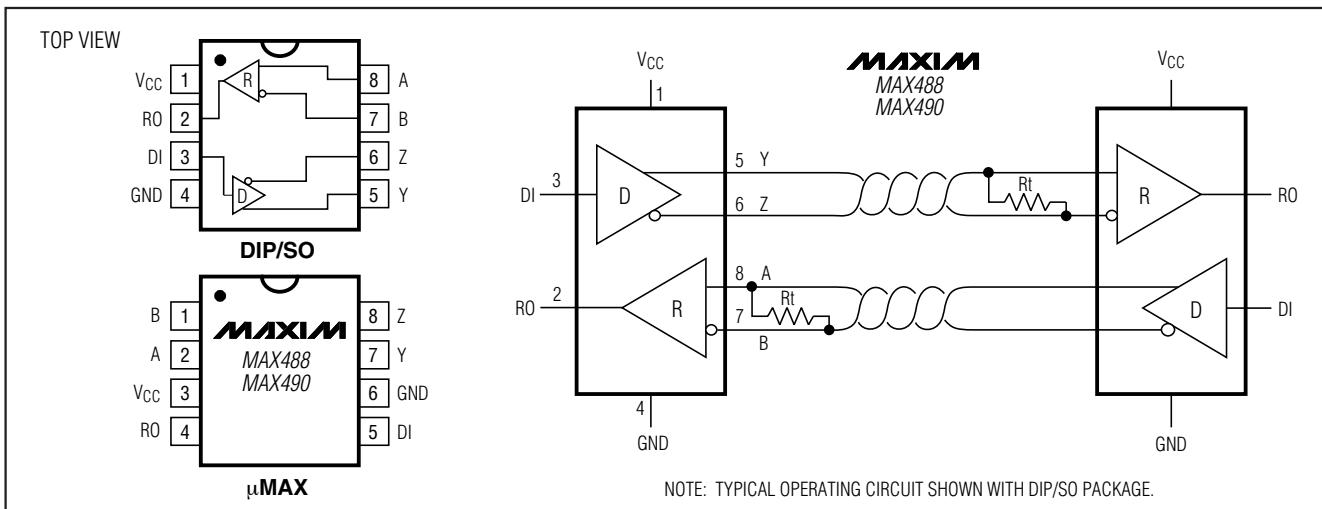


Figure 2. MAX488/MAX490 Pin Configuration and Typical Operating Circuit

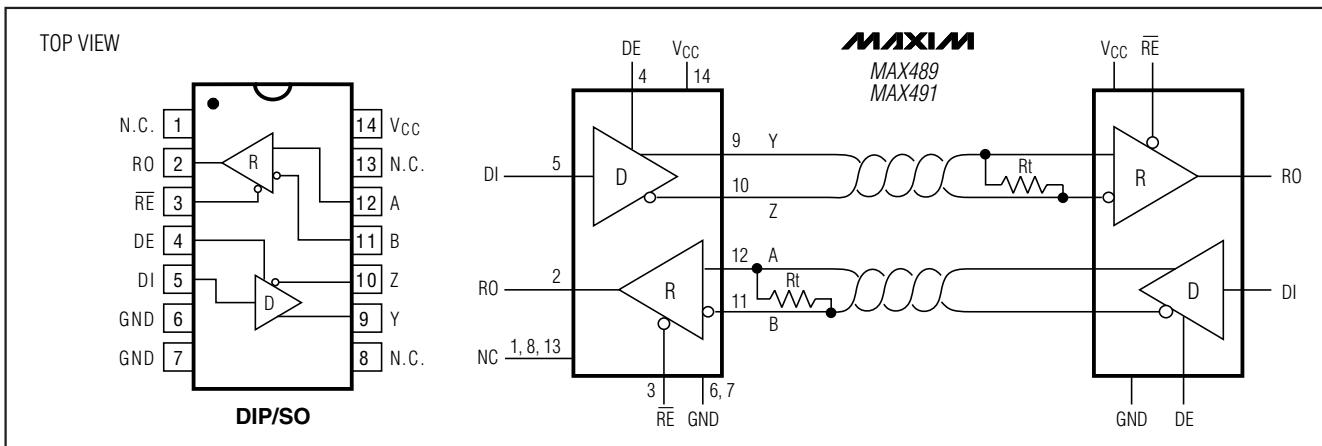


Figure 3. MAX489/MAX491 Pin Configuration and Typical Operating Circuit

### Applications Information

The MAX481/MAX483/MAX485/MAX487-MAX491 and MAX1487 are low-power transceivers for RS-485 and RS-422 communications. The MAX481, MAX485, MAX490, MAX491, and MAX1487 can transmit and receive at data rates up to 2.5Mbps, while the MAX483, MAX487, MAX488, and MAX489 are specified for data rates up to 250kbps. The MAX488-MAX491 are full-duplex transceivers while the MAX481, MAX483, MAX485, MAX487, and MAX1487 are half-duplex. In addition, Driver Enable (DE) and Receiver Enable (RE) pins are included on the MAX481, MAX483, MAX485, MAX487, MAX489, MAX491, and MAX1487. When disabled, the driver and receiver outputs are high impedance.

### MAX487/MAX1487: 128 Transceivers on the Bus

The  $48\text{k}\Omega$ ,  $\frac{1}{4}$ -unit-load receiver input impedance of the MAX487 and MAX1487 allows up to 128 transceivers on a bus, compared to the 1-unit load ( $12\text{k}\Omega$  input impedance) of standard RS-485 drivers (32 transceivers maximum). Any combination of MAX487/MAX1487 and other RS-485 transceivers with a total of 32 unit loads or less can be put on the bus. The MAX481/MAX483/MAX485 and MAX488-MAX491 have standard  $12\text{k}\Omega$  Receiver Input impedance.

# Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

## Test Circuits

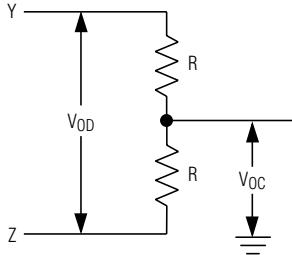


Figure 4. Driver DC Test Load

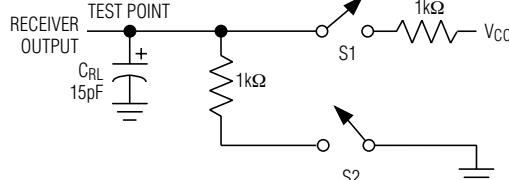


Figure 5. Receiver Timing Test Load

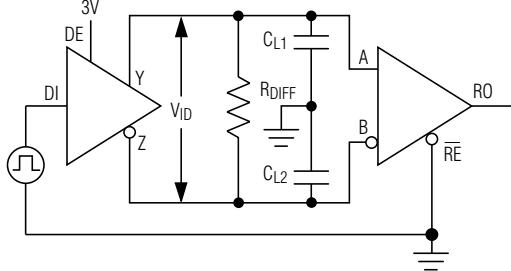


Figure 6. Driver/Receiver Timing Test Circuit

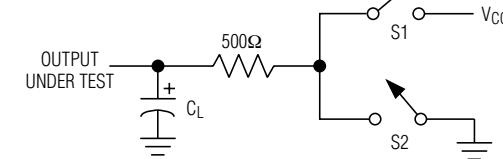


Figure 7. Driver Timing Test Load

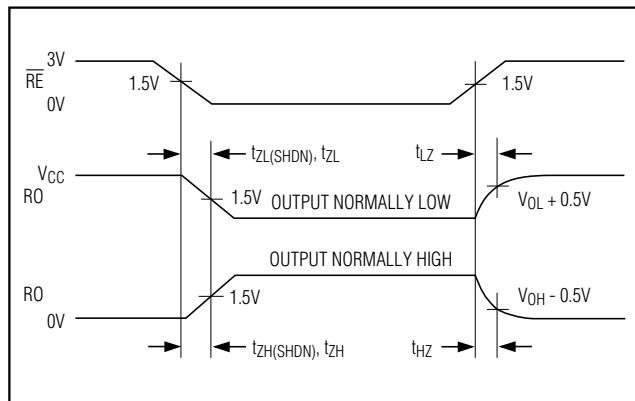
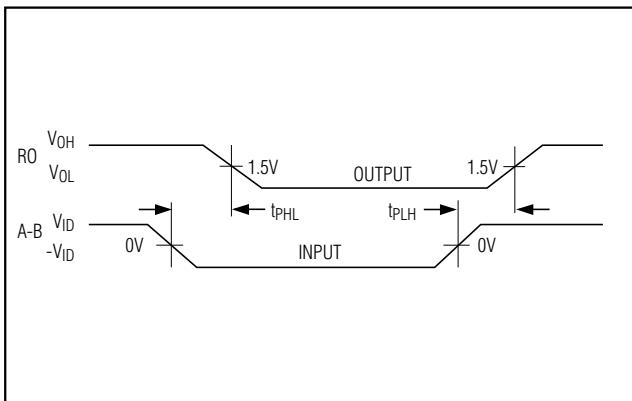
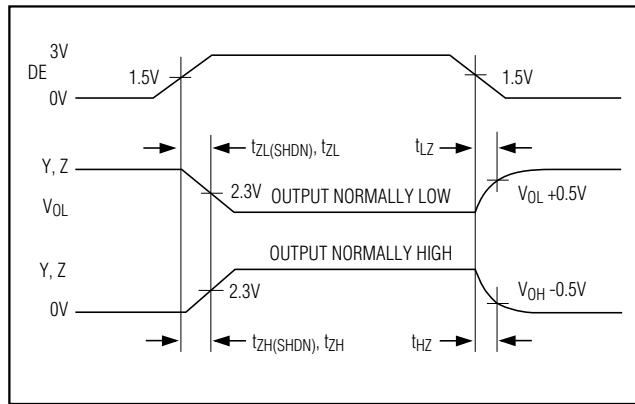
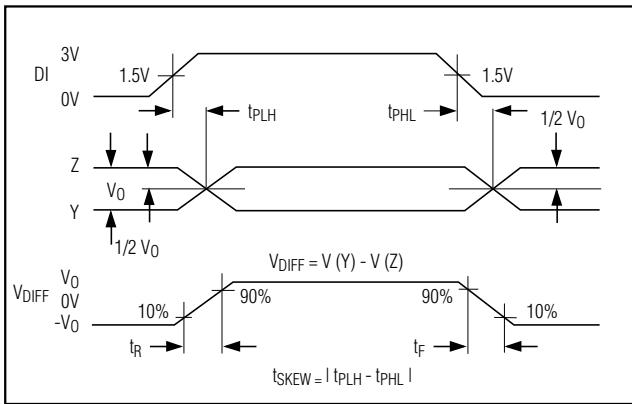
### MAX483/MAX487/MAX488/MAX489: Reduced EMI and Reflections

The MAX483 and MAX487–MAX489 are slew-rate limited, minimizing EMI and reducing reflections caused by improperly terminated cables. Figure 12 shows the driver output waveform and its Fourier analysis of a 150kHz signal transmitted by a MAX481, MAX485, MAX490, MAX491, or MAX487. High-frequency har-

monics with large amplitudes are evident. Figure 13 shows the same information displayed for a MAX483, MAX487, MAX488, or MAX489 transmitting under the same conditions. Figure 13's high-frequency harmonics have much lower amplitudes, and the potential for EMI is significantly reduced.

## Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

### Switching Waveforms



### Function Tables (MAX481/MAX483/MAX485/MAX487/MAX1487)

**Table 1. Transmitting**

INPUTS			OUTPUTS	
RE	DE	DI	Z	Y
X	1	1	0	1
X	1	0	1	0
0	0	X	High-Z	High-Z
1	0	X	High-Z*	High-Z*

X = Don't care

High-Z = High impedance

\* Shutdown mode for MAX481/MAX483/MAX487

**Table 2. Receiving**

INPUTS			OUTPUT
RE	DE	A-B	RO
0	0	$\geq +0.2V$	1
0	0	$\leq -0.2V$	0
0	0	Inputs open	1
1	0	X	High-Z*

X = Don't care

High-Z = High impedance

\* Shutdown mode for MAX481/MAX483/MAX487

## Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

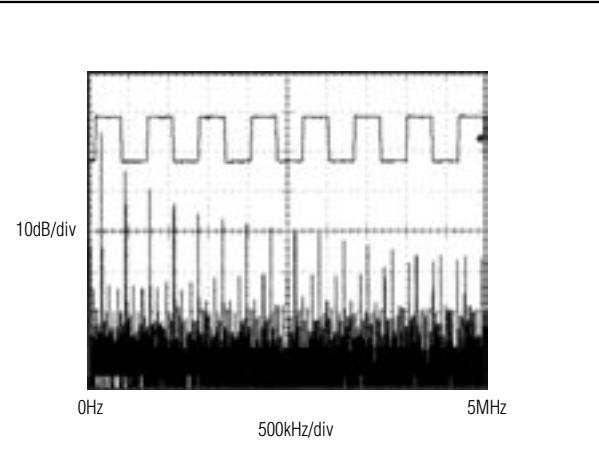


Figure 12. Driver Output Waveform and FFT Plot of MAX481/MAX485/MAX490/MAX491/MAX1487 Transmitting a 150kHz Signal

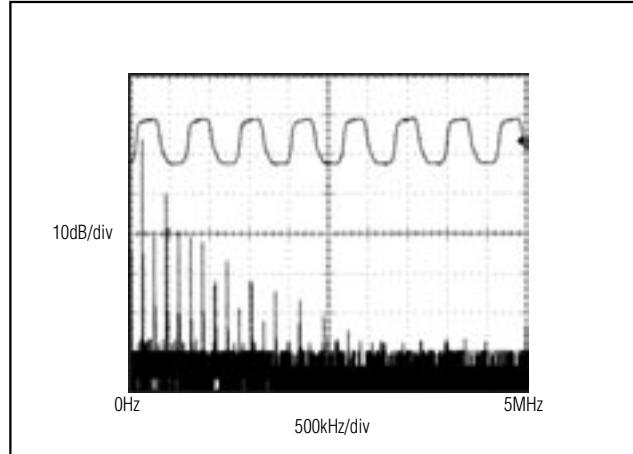


Figure 13. Driver Output Waveform and FFT Plot of MAX483/MAX487-MAX489 Transmitting a 150kHz Signal

### Low-Power Shutdown Mode (MAX481/MAX483/MAX487)

A low-power shutdown mode is initiated by bringing both  $\overline{RE}$  high and  $DE$  low. The devices will not shut down unless both the driver and receiver are disabled. In shutdown, the devices typically draw only  $0.1\mu A$  of supply current.

$\overline{RE}$  and  $DE$  may be driven simultaneously; the parts are guaranteed not to enter shutdown if  $\overline{RE}$  is high and  $DE$  is low for less than 50ns. If the inputs are in this state for at least 600ns, the parts are guaranteed to enter shutdown.

For the MAX481, MAX483, and MAX487, the  $t_{ZH}$  and  $t_{ZL}$  enable times assume the part was not in the low-power shutdown state (the MAX485/MAX488-MAX491 and MAX1487 can not be shut down). The  $t_{ZH(SHDN)}$  and  $t_{ZL(SHDN)}$  enable times assume the parts were shut down (see *Electrical Characteristics*).

It takes the drivers and receivers longer to become enabled from the low-power shutdown state ( $t_{ZH(SHDN)}$ ,  $t_{ZL(SHDN)}$ ) than from the operating mode ( $t_{ZH}$ ,  $t_{ZL}$ ). (The parts are in operating mode if the  $\overline{RE}$ ,  $DE$  inputs equal a logical 0,1 or 1,1 or 0, 0.)

### Driver Output Protection

Excessive output current and power dissipation caused by faults or by bus contention are prevented by two mechanisms. A foldback current limit on the output stage provides immediate protection against short circuits over the whole common-mode voltage range (see *Typical Operating Characteristics*). In addition, a thermal shutdown circuit forces the driver outputs into a high-impedance state if the die temperature rises excessively.

### Propagation Delay

Many digital encoding schemes depend on the difference between the driver and receiver propagation delay times. Typical propagation delays are shown in Figures 15–18 using Figure 14's test circuit.

The difference in receiver delay times,  $|t_{PLH} - t_{PHL}|$ , is typically under 13ns for the MAX481, MAX485, MAX490, MAX491, and MAX1487 and is typically less than 100ns for the MAX483 and MAX487-MAX489.

The driver skew times are typically 5ns (10ns max) for the MAX481, MAX485, MAX490, MAX491, and MAX1487, and are typically 100ns (800ns max) for the MAX483 and MAX487-MAX489.

## Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

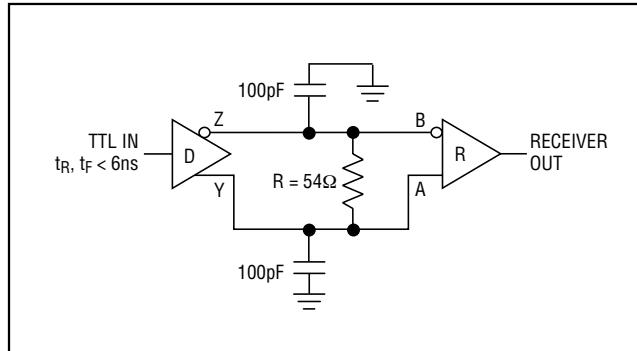


Figure 14. Receiver Propagation Delay Test Circuit

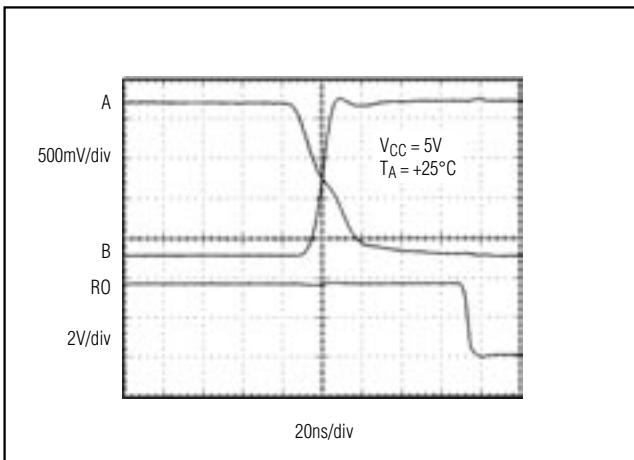


Figure 15. MAX481/MAX485/MAX490/MAX491/MAX1487 Receiver  $t_{PHL}$

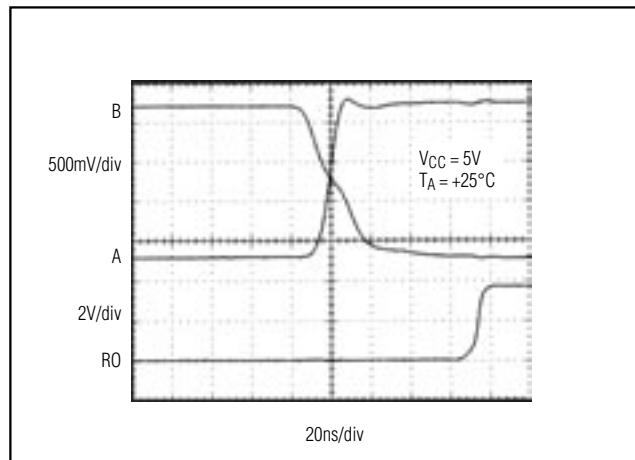


Figure 16. MAX481/MAX485/MAX490/MAX491/MAX1487 Receiver  $t_{PLH}$

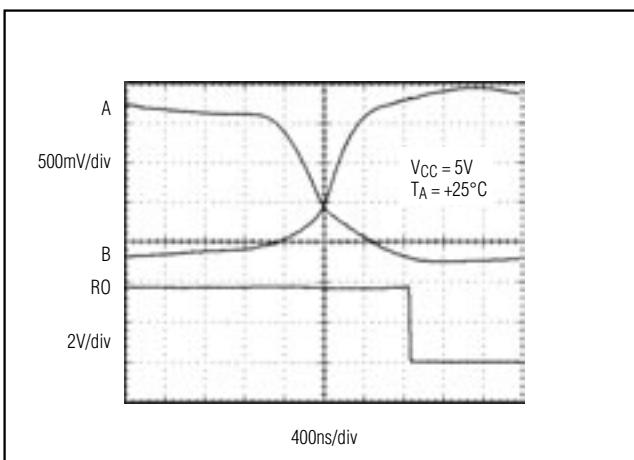


Figure 17. MAX483, MAX487-MAX489 Receiver  $t_{PHL}$

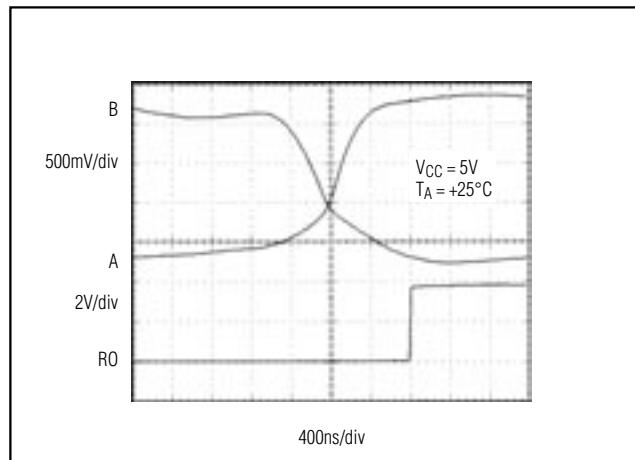


Figure 18. MAX483, MAX487-MAX489 Receiver  $t_{PLH}$

# Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

## Line Length vs. Data Rate

The RS-485/RS-422 standard covers line lengths up to 4000 feet. For line lengths greater than 4000 feet, see Figure 23.

Figures 19 and 20 show the system differential voltage for the parts driving 4000 feet of 26AWG twisted-pair wire at 110kHz into 120Ω loads.

## Typical Applications

The MAX481, MAX483, MAX485, MAX487-MAX491, and MAX1487 transceivers are designed for bidirectional data communications on multipoint bus transmission lines.

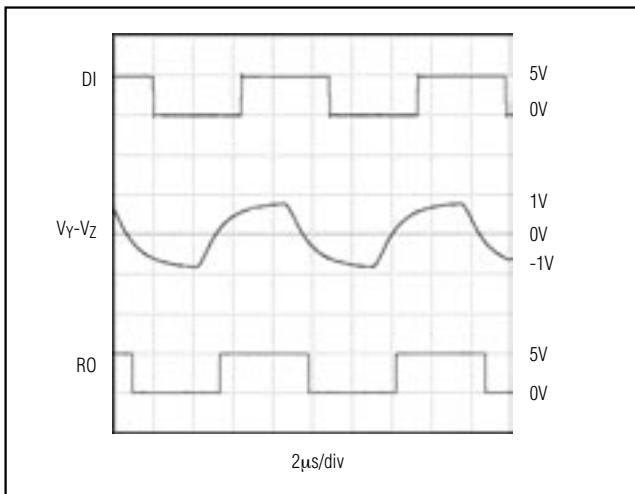


Figure 19. MAX481/MAX485/MAX490/MAX491/MAX1487 System Differential Voltage at 110kHz Driving 4000ft of Cable

Figures 21 and 22 show typical network applications circuits. These parts can also be used as line repeaters, with cable lengths longer than 4000 feet, as shown in Figure 23.

To minimize reflections, the line should be terminated at both ends in its characteristic impedance, and stub lengths off the main line should be kept as short as possible. The slew-rate-limited MAX483 and MAX487-MAX489 are more tolerant of imperfect termination.

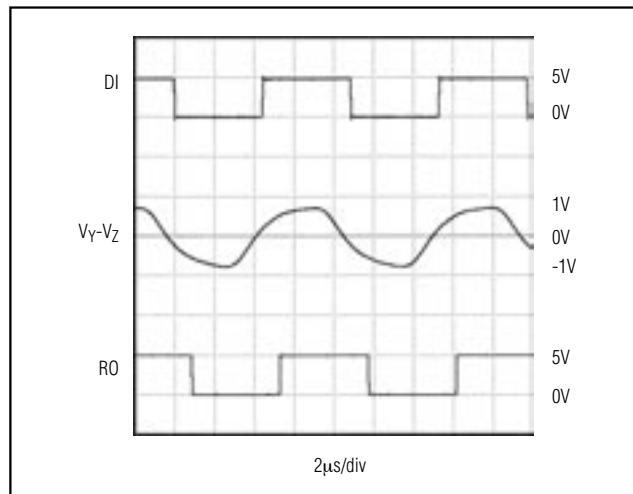


Figure 20. MAX483, MAX487-MAX489 System Differential Voltage at 110kHz Driving 4000ft of Cable

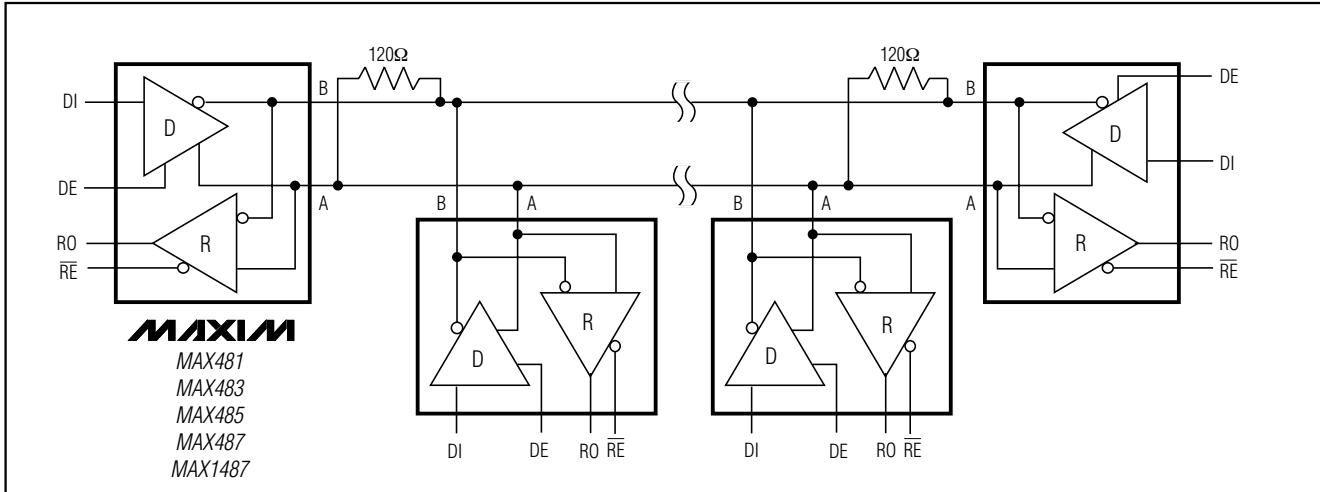


Figure 21. MAX481/MAX483/MAX485/MAX487/MAX1487 Typical Half-Duplex RS-485 Network

## **Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers**

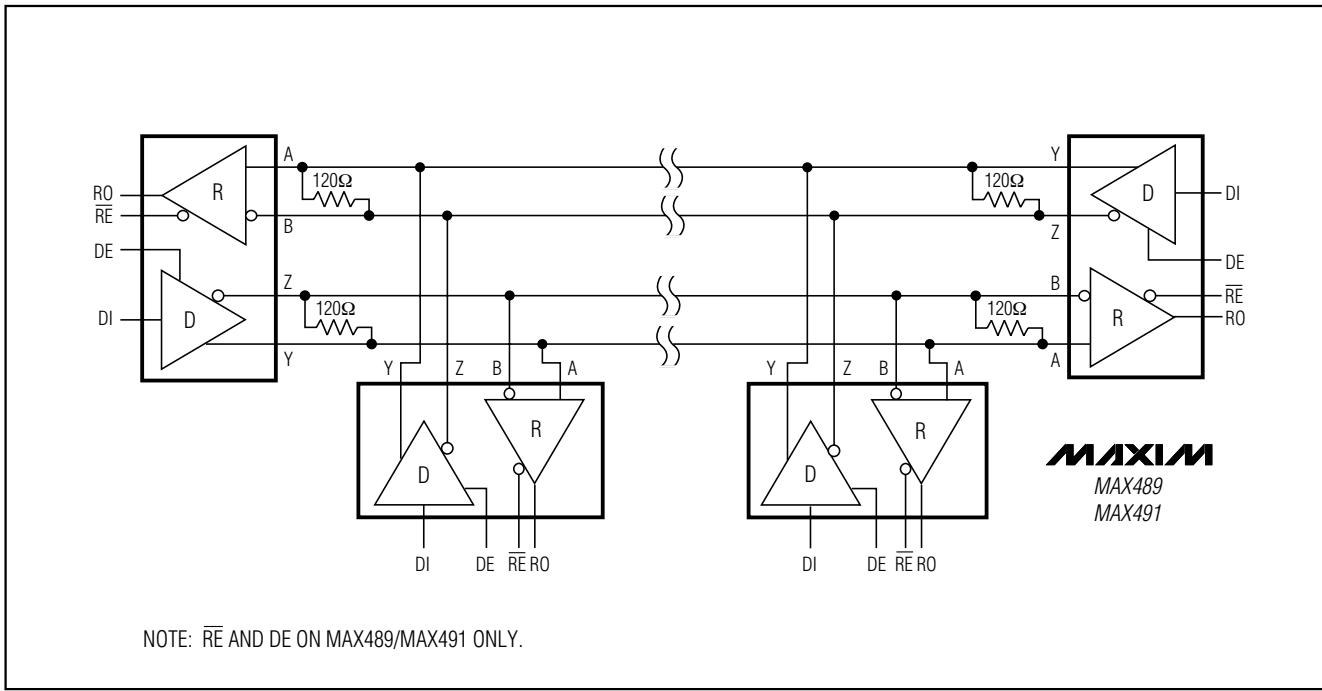


Figure 22. MAX488-MAX491 Full-Duplex RS-485 Network

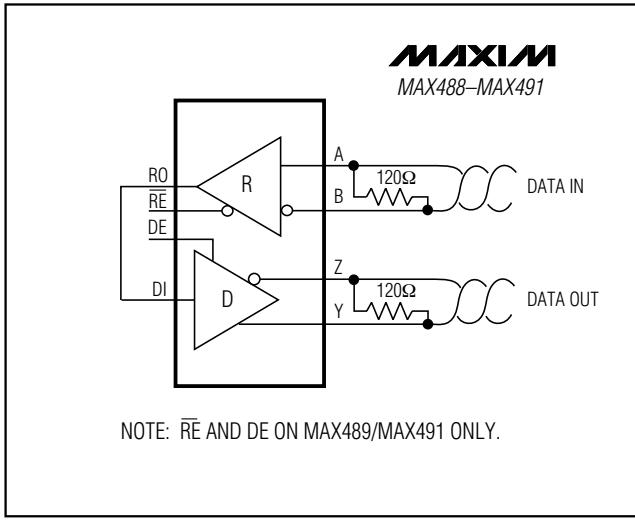


Figure 23. Line Repeater for MAX488-MAX491

### **Isolated RS-485**

For isolated RS-485 applications, see the MAX253 and MAX1480 data sheets.

# Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

## Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
<b>MAX481CPA</b>	0°C to +70°C	8 Plastic DIP
MAX481CSA	0°C to +70°C	8 SO
MAX481CUA	0°C to +70°C	8 µMAX
MAX481C/D	0°C to +70°C	Dice*
MAX481EPA	-40°C to +85°C	8 Plastic DIP
MAX481ESA	-40°C to +85°C	8 SO
MAX481MJA	-55°C to +125°C	8 CERDIP
<b>MAX483CPA</b>	0°C to +70°C	8 Plastic DIP
MAX483CSA	0°C to +70°C	8 SO
MAX483CUA	0°C to +70°C	8 µMAX
MAX483C/D	0°C to +70°C	Dice*
MAX483EPA	-40°C to +85°C	8 Plastic DIP
MAX483ESA	-40°C to +85°C	8 SO
MAX483MJA	-55°C to +125°C	8 CERDIP
<b>MAX485CPA</b>	0°C to +70°C	8 Plastic DIP
MAX485CSA	0°C to +70°C	8 SO
MAX485CUA	0°C to +70°C	8 µMAX
MAX485C/D	0°C to +70°C	Dice*
MAX485EPA	-40°C to +85°C	8 Plastic DIP
MAX485ESA	-40°C to +85°C	8 SO
MAX485MJA	-55°C to +125°C	8 CERDIP
<b>MAX487CPA</b>	0°C to +70°C	8 Plastic DIP
MAX487CSA	0°C to +70°C	8 SO
MAX487CUA	0°C to +70°C	8 µMAX
MAX487C/D	0°C to +70°C	Dice*
MAX487EPA	-40°C to +85°C	8 Plastic DIP
MAX487ESA	-40°C to +85°C	8 SO
MAX487MJA	-55°C to +125°C	8 CERDIP
<b>MAX488CPA</b>	0°C to +70°C	8 Plastic DIP
MAX488CSA	0°C to +70°C	8 SO
MAX488CUA	0°C to +70°C	8 µMAX
MAX488C/D	0°C to +70°C	Dice*
MAX488EPA	-40°C to +85°C	8 Plastic DIP
MAX488ESA	-40°C to +85°C	8 SO
MAX488MJA	-55°C to +125°C	8 CERDIP
<b>MAX489CPD</b>	0°C to +70°C	14 Plastic DIP
MAX489CSD	0°C to +70°C	14 SO
MAX489C/D	0°C to +70°C	Dice*
MAX489EPD	-40°C to +85°C	14 Plastic DIP
MAX489ESD	-40°C to +85°C	14 SO
MAX489MJD	-55°C to +125°C	14 CERDIP

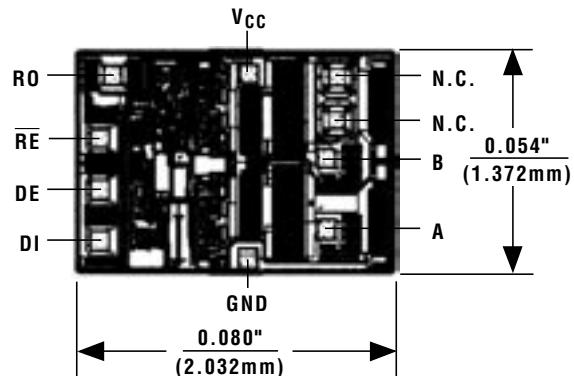
## Ordering Information (continued)

PART	TEMP. RANGE	PIN-PACKAGE
<b>MAX490CPA</b>	0°C to +70°C	8 Plastic DIP
MAX490CSA	0°C to +70°C	8 SO
MAX490CUA	0°C to +70°C	8 µMAX
MAX490C/D	0°C to +70°C	Dice*
MAX490EPA	-40°C to +85°C	8 Plastic DIP
MAX490ESA	-40°C to +85°C	8 SO
MAX490MJA	-55°C to +125°C	8 CERDIP
<b>MAX491CPD</b>	0°C to +70°C	14 Plastic DIP
MAX491CSD	0°C to +70°C	14 SO
MAX491C/D	0°C to +70°C	Dice*
MAX491EPD	-40°C to +85°C	14 Plastic DIP
MAX491ESD	-40°C to +85°C	14 SO
MAX491MJD	-55°C to +125°C	14 CERDIP
<b>MAX1487CPA</b>	0°C to +70°C	8 Plastic DIP
MAX1487CSA	0°C to +70°C	8 SO
MAX1487CUA	0°C to +70°C	8 µMAX
MAX1487C/D	0°C to +70°C	Dice*
MAX1487EPA	-40°C to +85°C	8 Plastic DIP
MAX1487ESA	-40°C to +85°C	8 SO
MAX1487MJA	-55°C to +125°C	8 CERDIP

\* Contact factory for dice specifications.

## Chip Topographies

### MAX481/MAX483/MAX485/MAX487/MAX1487

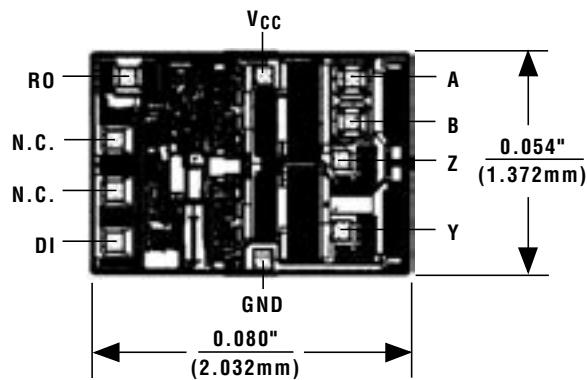


**MAX481/MAX483/MAX485/MAX487-MAX491/MAX1487**

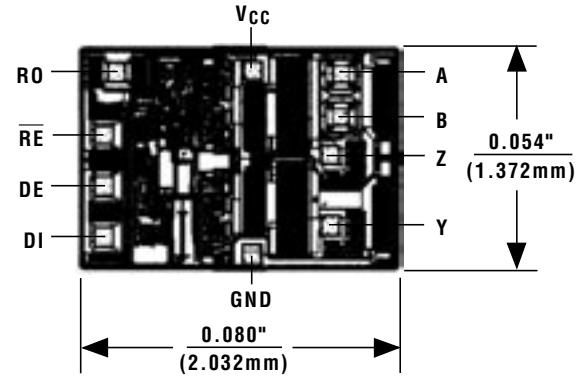
## Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

### Chip Topographies (continued)

MAX488/MAX490



MAX489/MAX491

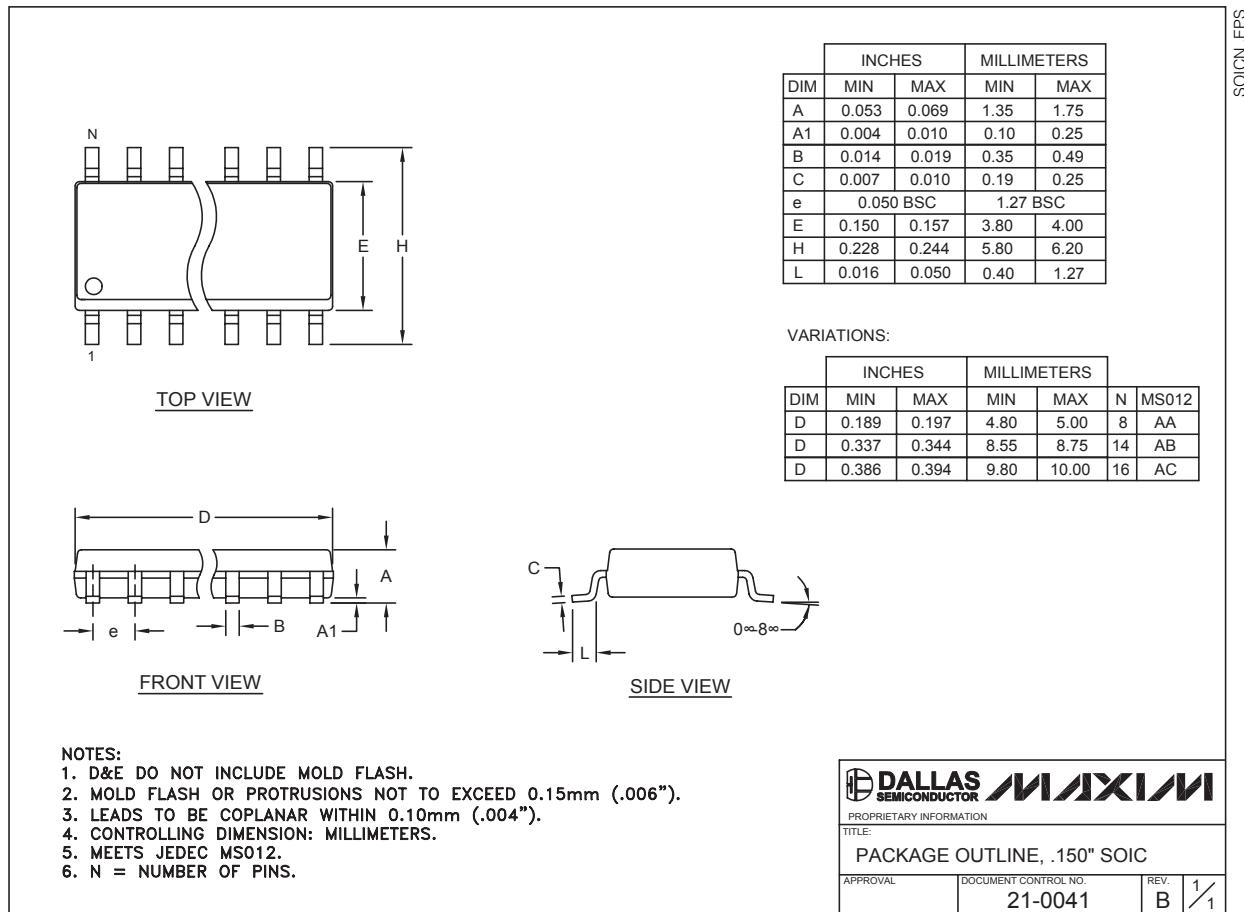


TRANSISTOR COUNT: 248  
SUBSTRATE CONNECTED TO GND

# Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

## Package Information

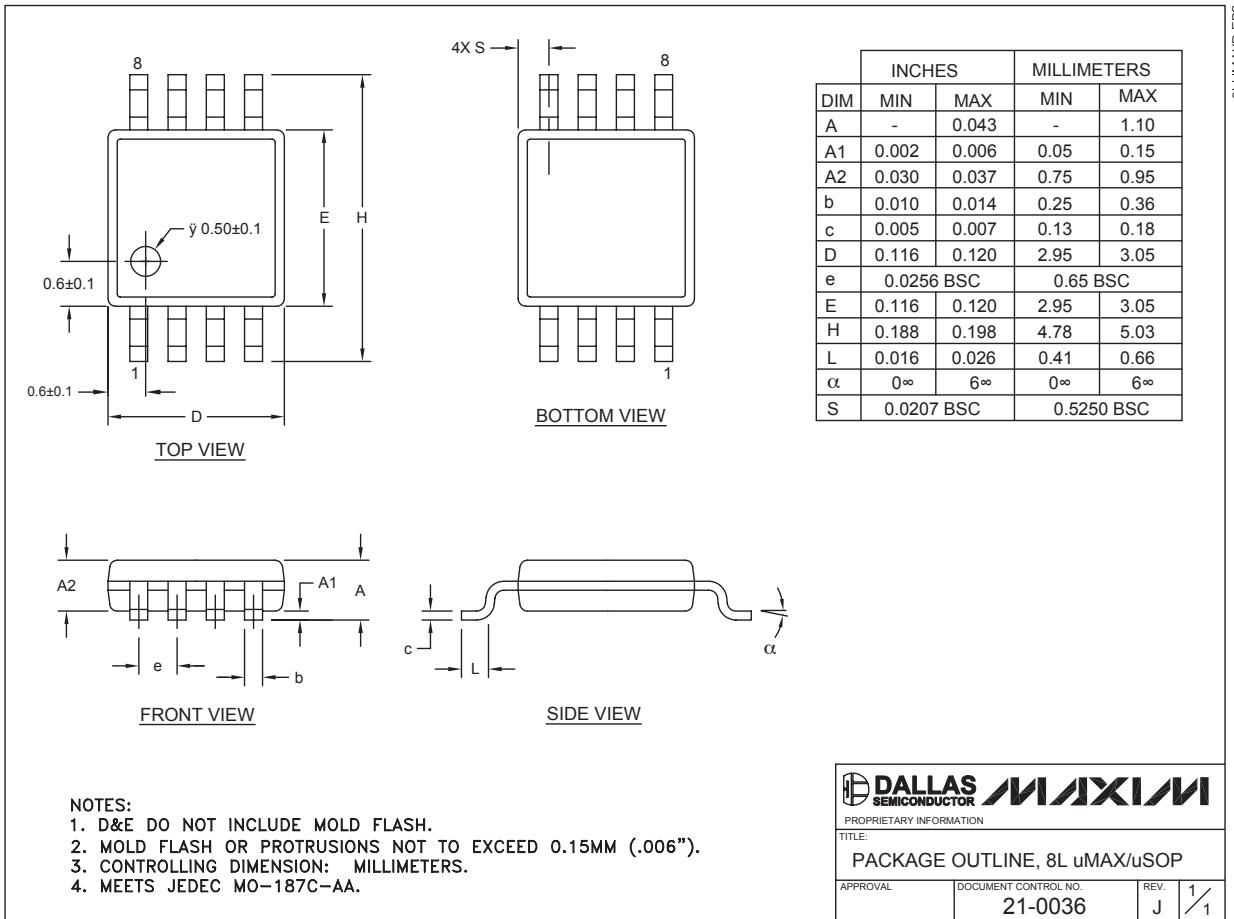
(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)



# Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

## Package Information (continued)

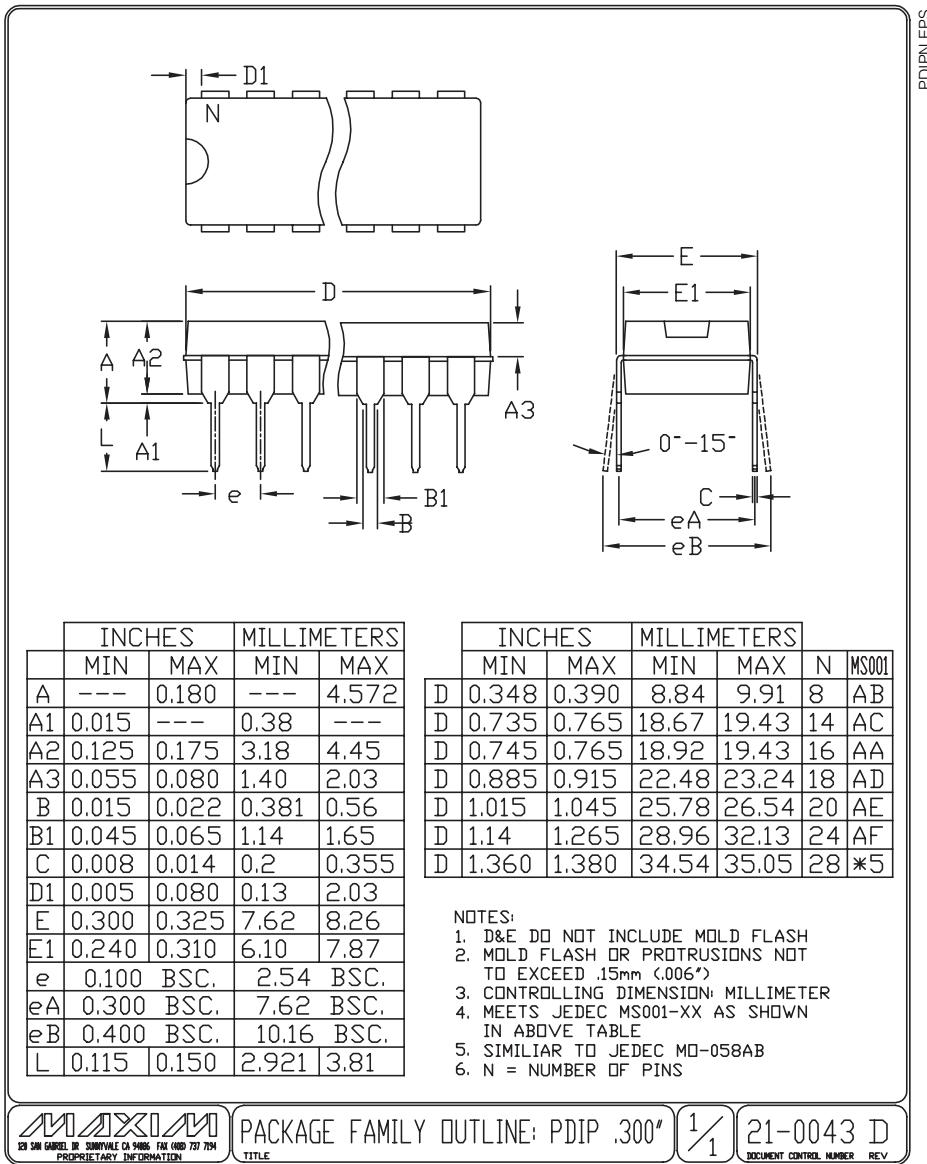
(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)



# Low-Power, Slew-Rate-Limited RS-485/RS-422 Transceivers

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)



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